CHAPTER 3

METHODOLOGY

To optimize result of the research, this study was divided into several stages, namely to stage the engine performance. This process can be used to determine the effect of ethanol on performance and emissions in gasoline engines. Testing is conducted using a four-cylinder gasoline engine injection port four strokes coupled with the dynamometer. The experiment is carried out in half load and full load conditions. This experiment resulted in some of the performance engines, engine power, torque, fuel consumption, engine temperature, exhaust temperature, and exhaust gas emissions by using gasoline fuel, ethanol 10.0% (E10), ethanol 20.0% (E20), and ethanol 30.0% (E30).

The experiment on steady flow is intended to determine the form of the flow as it enters the combustion chamber. Testing is done using a flow bench. The type of airflow in the engine cylinder head and intake manifold is taken from the engine experiment. The flow form in the intake manifold was determined using the intake manifold standard and the swirl generator, which is done in computer fluid dynamic (CFD). The intake manifold was tested using variations of the intake valve lift and the airflow speed difference.

3.1 ENGINE TEST BED

3.1.1 Ethanol Fuel Preparation

In this study, the ethanol used is ethanol 95.0% purity with the specifications for the laboratory grade. To get ethanol with guaranteed quality, in this study ethanol purchased from chemical suppliers. Ethanol was chosen to obtain ethanol with a fairly good quality with minimum water content; high water content in ethanol led to the mixture of gasoline and ethanol which would be more difficult. To get a better fuel mixture, to prepare for the fuel with care, especially equipment that is used as a measuring cup, mixer and so forth.

In this study, E10, E20 and E30 were obtained by mixing ethanol with a gasoline using the volume ratio of the fuel. To get the E10, 900 ml gasoline fuel was put into the burette and ethanol was added until the fuel reached 1,000 ml. Next, the fuel was shaken to mix the gasoline and ethanol perfectly. More fuel can be obtained by scaling-up in this process. Results of testing the properties of gasoline fuel and the ethanol/gasoline blend is show in Table 3.1.

Table 3.1. Properties of different ethanol/gasoline blended fuels (E0, E10, E20, E30)

	Test fuel				Method
Property item	E0	E10	E20	E30	
Density (kg/l at 15.5°C)	0.7575	0.7608	0.7645	0.7682	ASTM D4052
RON (octane number)	95.4	98.1	100.7	102.4	ASTM D2699
RVP (kPa at 37.8°C)	53.7	59.6	58.3	56.8	ASTM D5191
Sulfur (wt%)	0.0061	0.0055	0.0049	0.0045	ASTM D5453
Washed gum (mg/100 ml)	0.2	0.2	0.6	0.2	ASTM D381
Unwashed gum (mg/100 ml)	18.8	17.4	15	14.4	
Lead content (g/l)	<0.0025	<0.0025	<0.0025	<0.0025	ASTM D3237
Corrosivity (3 h at 50°C)	1a	1a	1a	1a	ASTM D130
Distillation temperature (°C)					ASTM D86
IBP	35.5	37.8	36.7	39.5	
10 vol%	54.5	50.8	52.8	54.8	
50 vol%	94.4	71.1	70.3	72.4	
90 vol%	167.3	166.4	163	159.3	
End point	197	197.5	198.6	198.3	
Heating value (cal/g)	10176	9511	9316	8680	
Carbon (wt%)	86.6	86.7	87.6	86	
Hydrogen (wt%)	13.3	13.2	12.3	13.9	
Residue (vol%)	1.7	1.5	1.5	1.5	
Color	Yellow	Yellow	Yellow	Yellow	Visual

3.1.2 Specification for the Engine Test

The engine used in this study is a Mitsubishi 4G92 port injection four-cylinder gasoline engine, inline over head valve (OHV), single over head camshaft (SOHC) spark ignition rated 63 horsepower (hp) at 5,500 revolutions per minute (rpm), with the specifications given in Table 3.2. Testing is done using gasoline fuel Ron 95, followed by the addition of E10 and E20. The addition of ethanol 30% (E30) or greater is less economical and E30 will reduce engine performance.

The engine is connected at the eddy current dynamometer; lay out experiment as shown in Figure 3-1 and for detail experiment shown at appendix. The analysis for the experiment finds the effect of engine torque, engine speed, fuel consumption, and throttle position. The eddy current dynamometer is a dry-gap rotor machine with either single or twin rotors, which operates in the air gap and is inherently capable of bidirectional operational.

Table 3.2. Engine specification

Engine Parameter	Value
Type	In-line OHV, SOCH
Motor Construction	4 cylinders, water cooled
Bore and Stroke	81 x 77.5 mm
Compression ratio	10: 1
Intake open	200^0(BTDC)
Intake close	420^0 (ABDC)
Exhaust open	520^0(BBDC)
Exhaust close	20^0(ATDC)

An outstanding feature of dry-gap eddy current dynamometer is its very wide performance characteristics. The capacity of the dynamometer is maximum torque of 150 Nm at 1,500–2,500 rpm and maximum power of 100 kW at 2,500–13,000 rpm. The overall size of the mechanical specification is 510 mm wide and 660 mm high from the platform to the center of the dynamometer shaft. The electrical specification for maximum excitation current is 6 amp dc. Coil resistance is 12–15 ohms and coil dynamometer is 500 m ohm.